



Armed Forces College of Medicine AFCM



Reflex Action And Its Properties

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INTENDED LEARNING OBJECTIVES (ILOs)



By the end of this lecture the student will be able to:

1. Define reflex arc
2. Identify components and types of reflex arc
3. Explain the properties of reflex action.

Reflex Arc



• Definition:

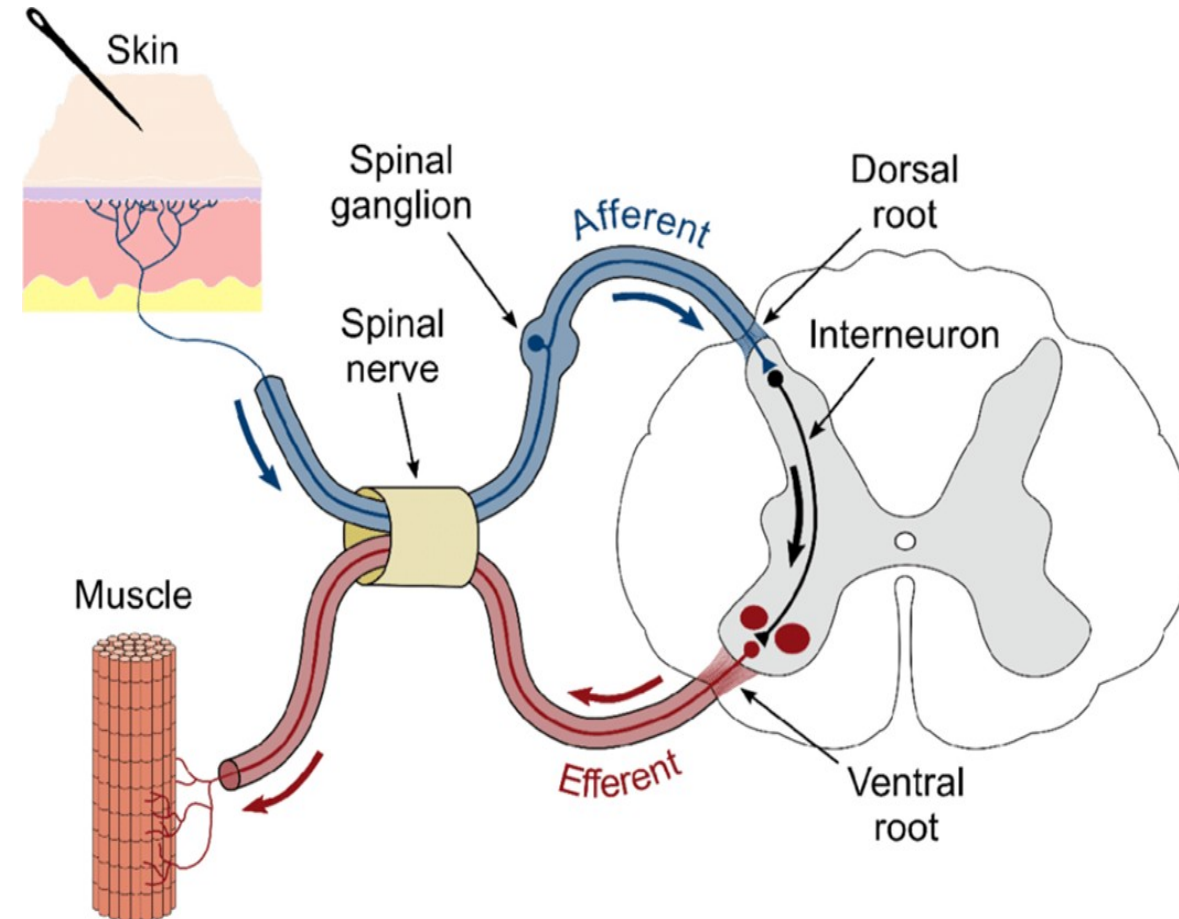
It is the basic unit of integrated reflex activity.

• Components:

Receptor,
Afferent,
Center (Interneuron)
Efferent
Response (effectors organ)

• Bell Magendi Law:

The dorsal root is sensory, while the ventral root is motor.



https://www.researchgate.net/figure/Schematic-representation-of-a-spinal-reflex-arc-A-pi-n-in-the-skin-produces-an-input_fig1_327199446

REFLEX ARC



• Functions of interneuron's:

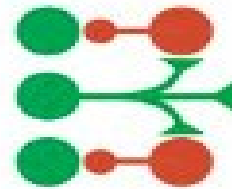
a-Divergence: to magnify spread of response.

b-Convergence: to magnify intensity of stimuli.

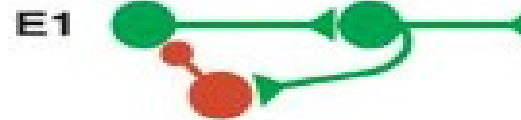
c- After discharge: to m
of response.

d-Interneuronal inhibit

• Lateral inhibition

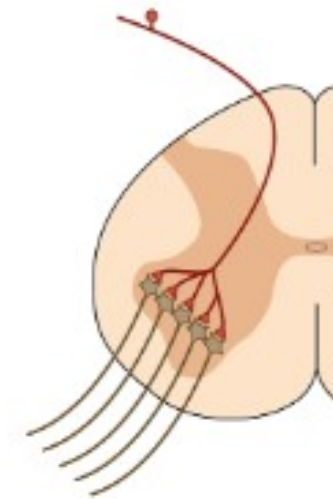


• Feedback/Recurrent inhibition



E1

A Divergence



B Convergence



<https://nba.uth.tmc.edu/neuroscience/m/s1/introduction.html>

Properties of reflex Action



- 1- Forward conduction.
- 2- Reflex delay
- 3- Reflex fatigue
- 4- Summation.
- 5- Irradiation & rebound.
- 6- Reciprocal innervation.
- 7- Recruitment.
- 8- After discharge.
- 9- Discharge zone & Subliminal fringe.
- 10- Facilitation.
- 11- Occlusion

Properties of reflex Action



1) Law of forward conduction:

Impulses pass from **pre**-synaptic to **post**-synaptic and not in the opposite direction. (Unidirectional flow).

2) Reflex delay:

-Reflex time: Time between **stimulation** of receptor and **response**.

(Time in **afferent** + **Central time** + **Efferent**)

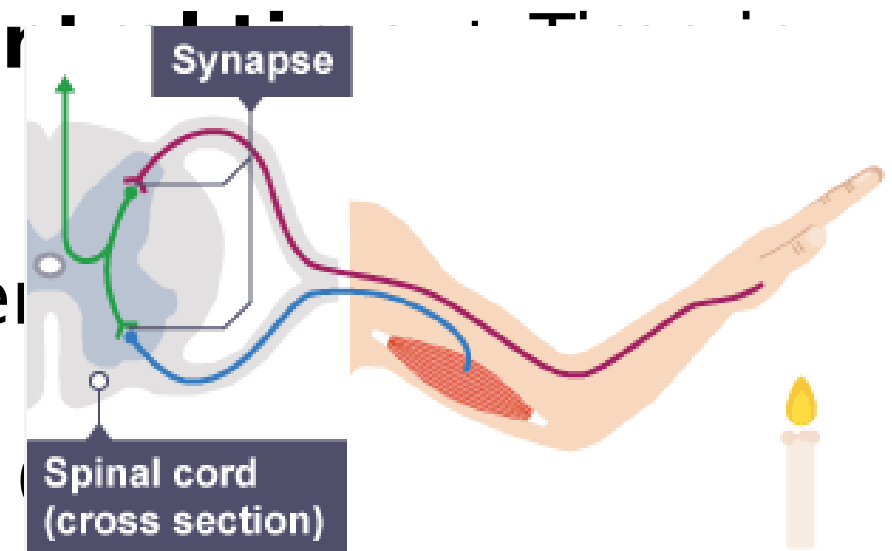
-Central time:

Reflex time - (time in afferent + in efferent)

- Synaptic Delay:

The time taken by only one synapse =

- No. of synapses: **Central time/synaptic delay.**



Properties of reflex Action



3) Fatigue:

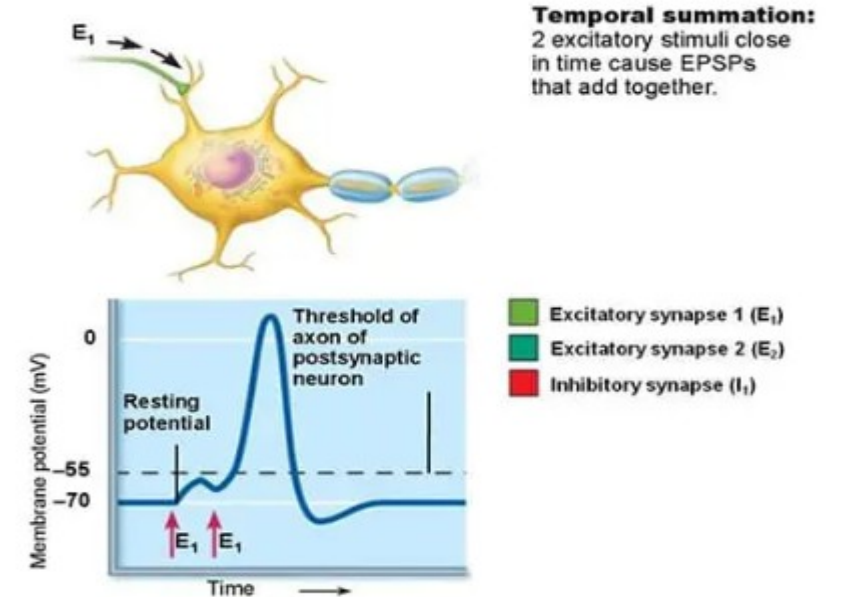
Due to exhaustion of chemical transmitter.

4) Summation

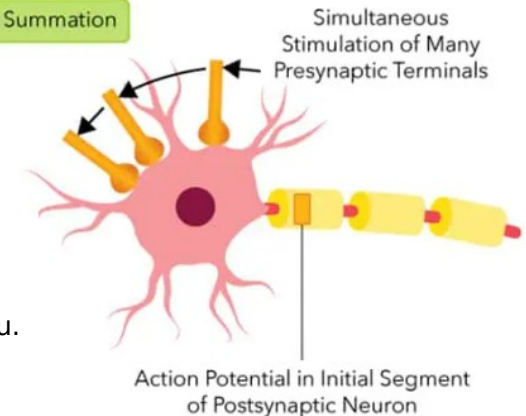
1-Temporal: By repetitive stimulation of the **same** neuron at frequent times on the condition that time between each 2 successive stimuli is **less than 15 msec.** (EPSP).

2-Spatial: Stimuli from different levels at the **same time**, e.g. micturition reflex.

TEMPORAL SUMMATION (EPSPS)



Spatial Summation



<https://www.assignments4u.com/temporal-vs-spatial-summation/>

Properties of reflex Action



5) Irradiation:

The strong stimulus activates not only the primary neural pathway involved in the reflex but also adjacent neural pathways, leading to a more widespread response (depends upon **divergence**). e.g. Flexor withdrawal reflex.

Rebound:

It is state of exaggerated response after initial period of inhibition.

- a) After mosquito bite, if we do pin prick, this causes temporary inhibition of scratching followed by exaggerated scratching.
- b) During crossed extensor reflex, if we do stimulation of the sole of the extended limb, this causes exaggerated extension of the flexed limb.

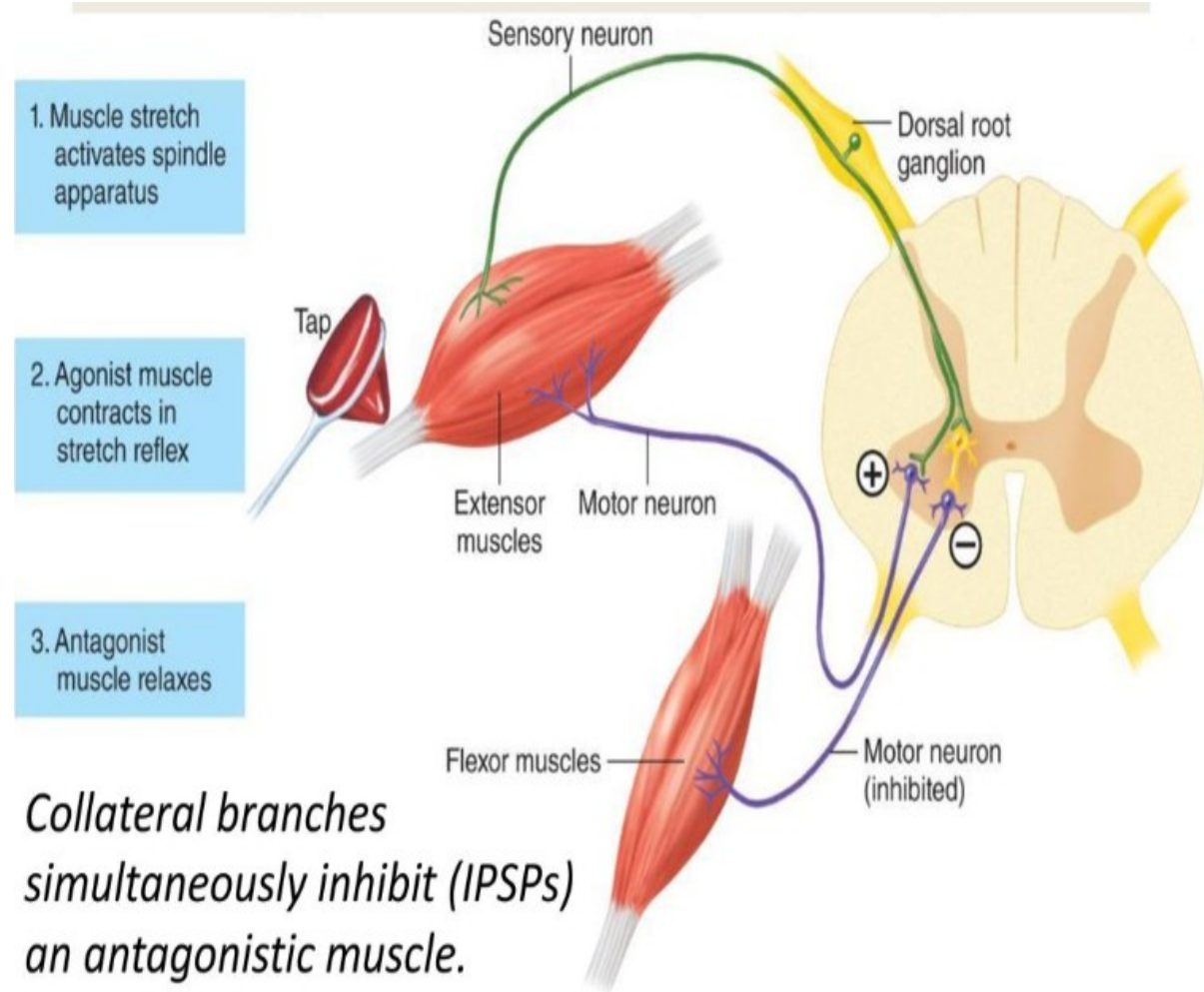
Properties of reflex Action



6) Reciprocal innervation

-Simultaneous contraction of certain group of muscles and relaxation of their antagonist, this is done by reciprocal inhibition circuits.

-This property is present in all reflexes **except positive supporting reaction.**



Properties of reflex Action



7) Recruitment:

It is the progressive activation of motor units in response to an increasing stimulus intensity.

Mechanism

1-Threshold Stimulation: A weak or subthreshold stimulus initially activates a minimal number of motor units which are the most easily excitable.

2-Increasing Stimulus Intensity: As the stimulus intensity increases, more motor units are recruited.

3-Henneman's Size Principle: motor units are recruited in an orderly manner, starting with smaller, lower-threshold motor units and progressing to larger, higher-threshold motor units. This principle ensures a smooth and graded recruitment pattern.

N.B:

Motor Unit: A.H.C.+ its axon+ no of muscle fibers supplied by this axon.

Properties of reflex Action



8) After discharge

It is continuation of discharge (response) after removal of the stimulus.

Examples:

(I) RAS (arousal and alert states):

Arousal response is due to collateral impulses (Visual, auditory & proprioceptive → stimulation of RAS → stimulation of thalamus → stimulation of C.C.

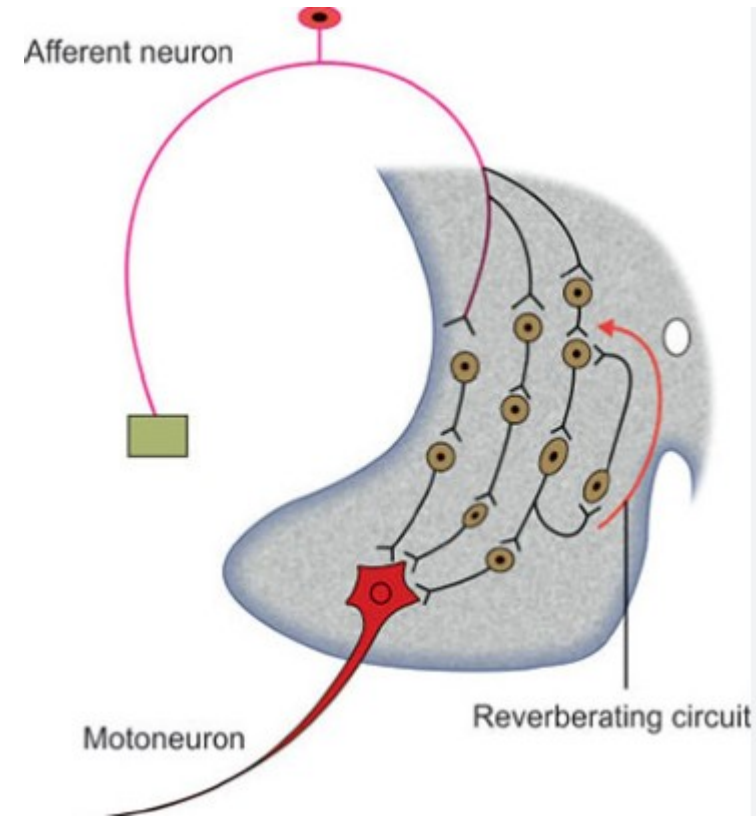
For alert state: continuation of a wakefulness after removal of collateral impulses, caused by + ve feedback mechanism.

(II) Short term memory:

Continuation of storage of information's after removal of the stimulus, and it is removed only by stronger stimulus.

(III) Flexor withdrawal reflex:

Continuation of flexion of elbow & shoulder joints



Properties of reflex Action



Mechanism:

(I) Synaptic after discharge:

It is **E.P.S.P.** which lasts for **15 msec** after removal of sub-threshold stimulus.

(II) Interneuronal after discharge:

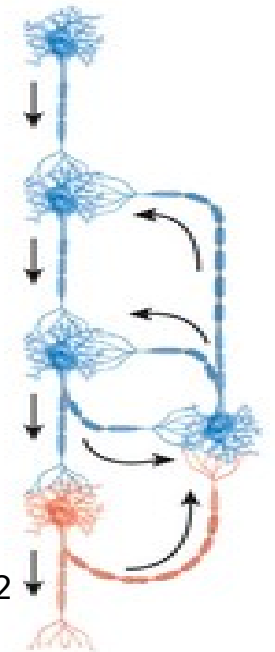
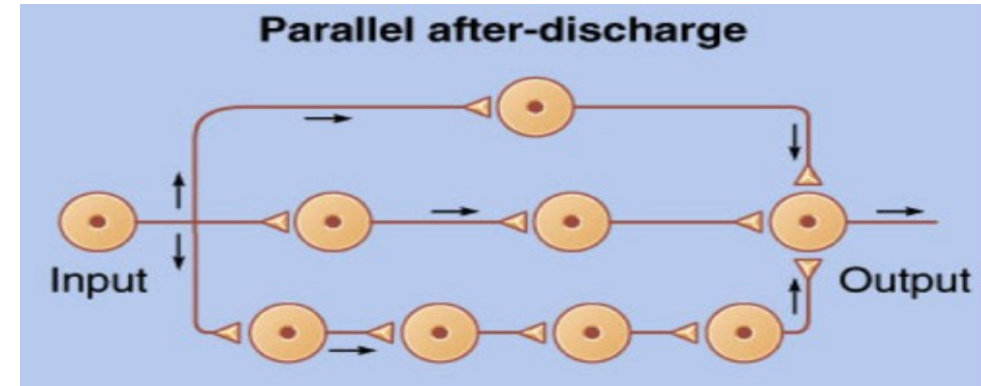
1-Parallel chain (open circuit):

Interneuron's connected with each other in parallel with intervening synapses, each synapse causes delay of 0.3-0.5 msec. Sudden removal of the stimulus doesn't cause sudden relaxation of the muscle.

2-Re-verbration (closed circuit):

Interneuron's are connected with each other in series. These are responsible for prolongation of response.

e.g. **cerebellum**

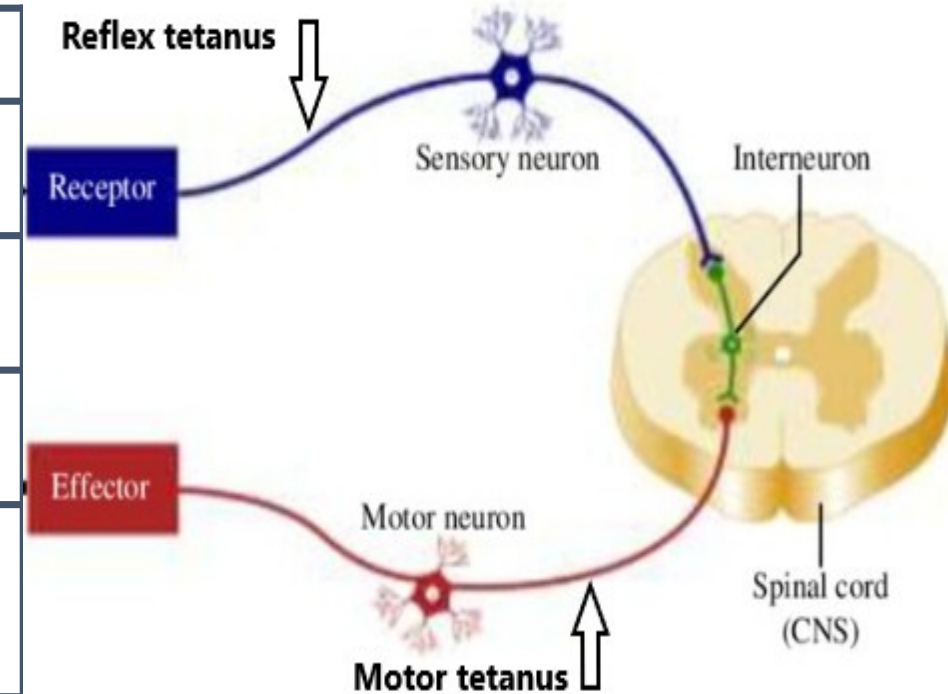


<https://pressbooks-dev.oer.hawaii.edu/anatomyandphysiology2021/chapter/12-nervous-tissue/>

Properties of reflex Action



| | Motor Tetanus | Reflex Tetanus |
|---------------------------------|-------------------------|-------------------------|
| 1.Cause | Stimulation of efferent | Stimulation of afferent |
| 2. After discharge | Absent | Present |
| 3. Recruitment | Absent | Present |
| 4. Delay (latent period) | No | Central |



Properties of reflex Action



9) Discharge zone Subliminal fringe:

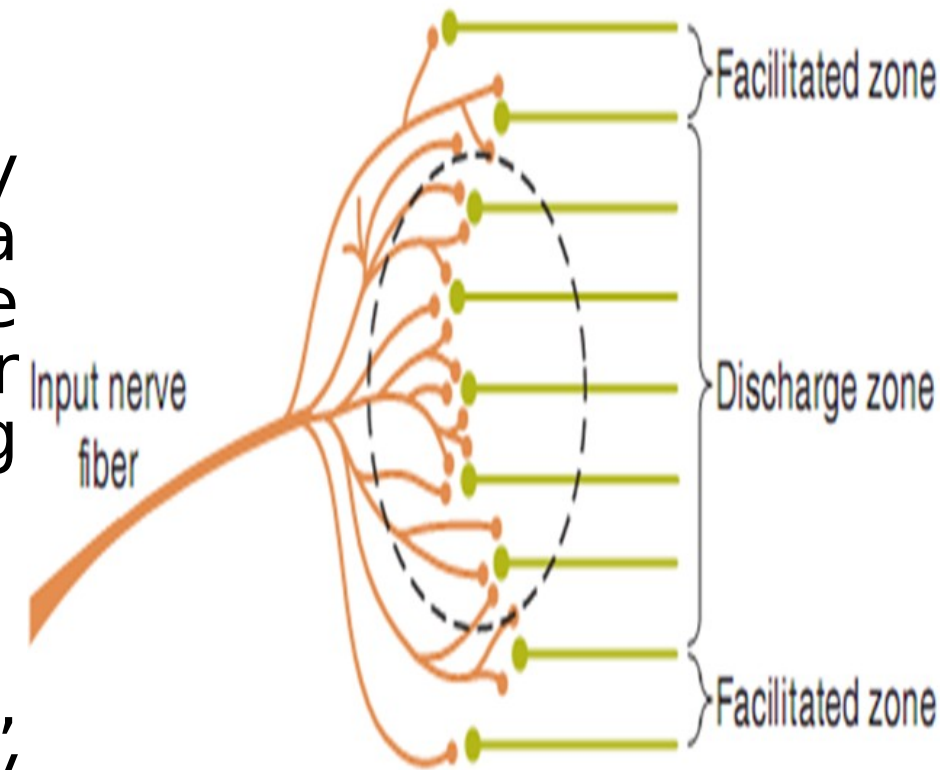
An afferent nerve fiber divides into many hundred terminal branches. Of these, a large number may terminate on one efferent neuron, while a smaller number terminate on other efferent neuron lying nearby.

-Discharge zone:

When an afferent neuron is stimulated, the **central** neurons that have many presynaptic terminals are excited to **threshold** level and AP is fired.

-Subliminal fringe (Facilitation zone):

Neurons in the **peripheral** zone are excited to **subthreshold** level only (their



Guyton and Hall, 2016

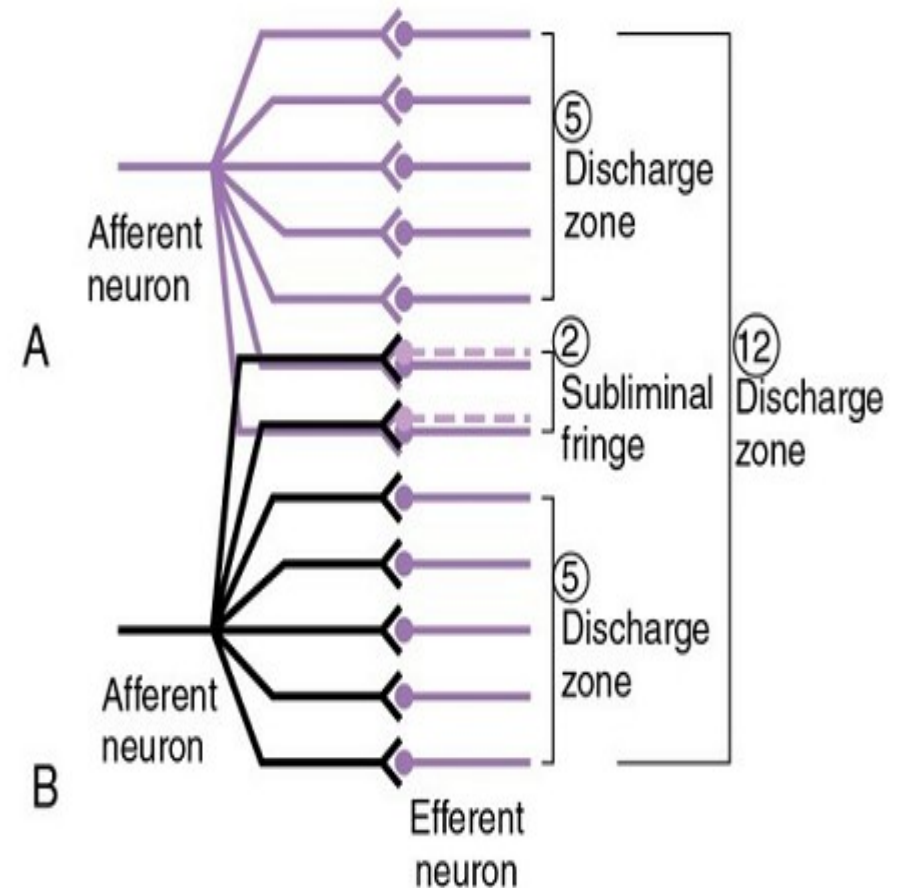
Properties of reflex Action



Because of subliminal fringe effect, stimulation of 2 nearby neurons with common interneuron with 2 **submaximal** stimuli gives → better response with **synchronous** stimulation (at the same time).

10) Facilitation:

Overlap of several afferent neurones on the same neurons in the periphery which are excited to **subthreshold level**.



Textbook of Medical Physiology, SECOND EDITION, Indu Khurana, MD, 2015, Elsevier

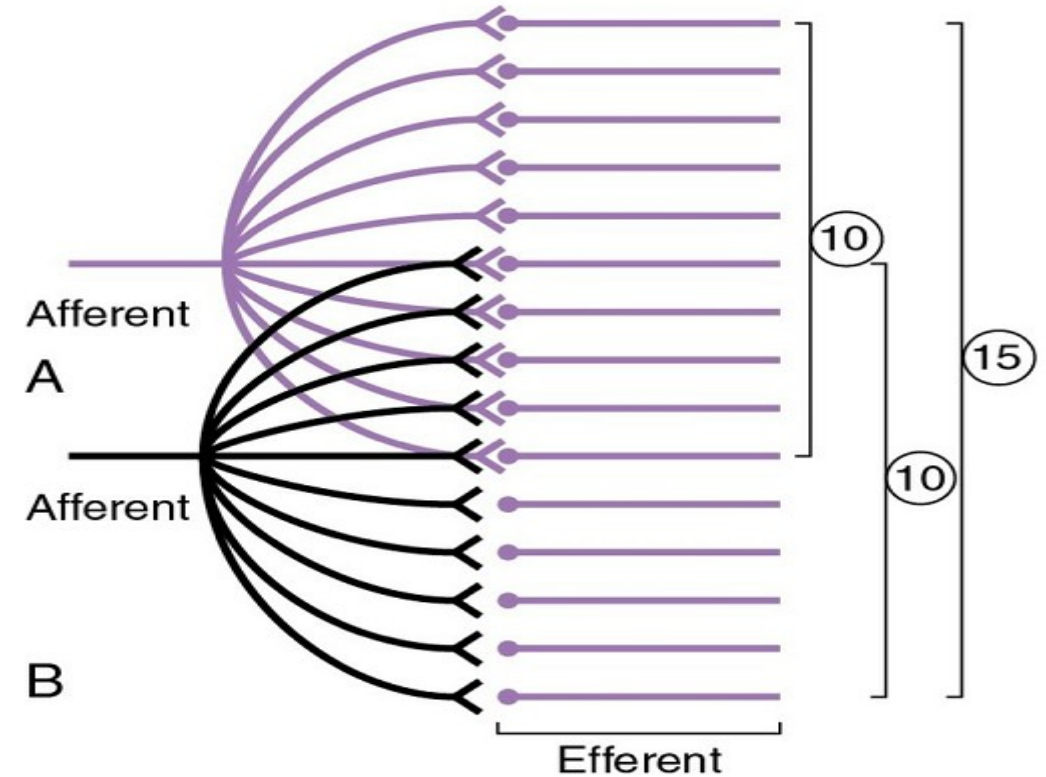
It depends upon **spatial summation**, e.g. micturition

Properties of reflex Action



11) Occlusion:

Stimulation of 2 nearby afferents with 2 **maximal stimuli** gives → better response with **Asynchronous** stimulation.



Textbook of Medical Physiology, SECOND EDITION,
Indu Khurana, MD, 2015, Elsevier



1- Which of the following is true about total reflex time?

- A. Needed from application of a stimulus to a receptor and the appearance of reflex contraction of a muscle.
- B. Needed from the entry of the nerve impulse in the spinal cord and its exit from it
- C. Needed for transmission of impulses across synapses.
- D. Needed for transmission of a neuronal signal from a presynaptic neuron to a postsynaptic neuron.
- E. Needed for transmission of a neuronal signal across interneurons.



2- The after discharge in a neural pool is based mainly upon which of the following?

- A. After discharge of individual neurons.
- B. Reverberating & parallel interneuron circuits.
- C. Convergence & divergence circuits.
- D. Occlusion.
- E. Recruitment.

Summary



- Reflex arc is the functional and structural unit of CNS.**
- Law of forward conduction: Impulses pass from pre-synaptic to post-synaptic and not in the opposite direction. (Unidirectional flow).**
- Time between stimulation of receptor and response is called Reflex time.**
- Fatigue is Due to exhaustion of chemical transmitter.**
- Summation is either temporal or spatial.**
- Irradiation is increasing the response with increased intensity of the stimulus.**
- Reciprocal innervation is simultaneous contraction of certain group of muscles and relaxation of their antagonist.**
- Recruitment is the gradual contraction of the muscle, inspite of sudden maximal stimulation.**
- After discharge is continuation of discharge (response) after removal of the stimulus.**
- Because of subliminal fringe effect, stimulation of 2 nearby neurons with common interneuron with 2 sub-maximal stimuli gives better response with synchronous stimulation.**

SUGGESTED TEXTBOOKS



1. Guyton and Hall textbook of medical physiology, thirteenth edition 2016, Elsevier, chapter 47, from page 595 to 606.



Thank You